Limits to the Exponential Advances in DWDM Filter Technology?

DARPA/MTO WDM for Military Platforms

April 18-19, 2000

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Philip J. Anthony

E-TEK Dynamics

San Jose CA

phil.anthony@e-tek.com

E-TEK DYNAMICS

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Limits to the Exponential Advances in DWDM Filter Technology?

DARPA/MTO WDM for Military Platforms

- Progress in DWDM Filtering Technology
  - Thin Film Filters
  - Arrayed Waveguide Gratings
  - Holographic Gratings
- Interleaver Status
- Roadmap for the Near Future

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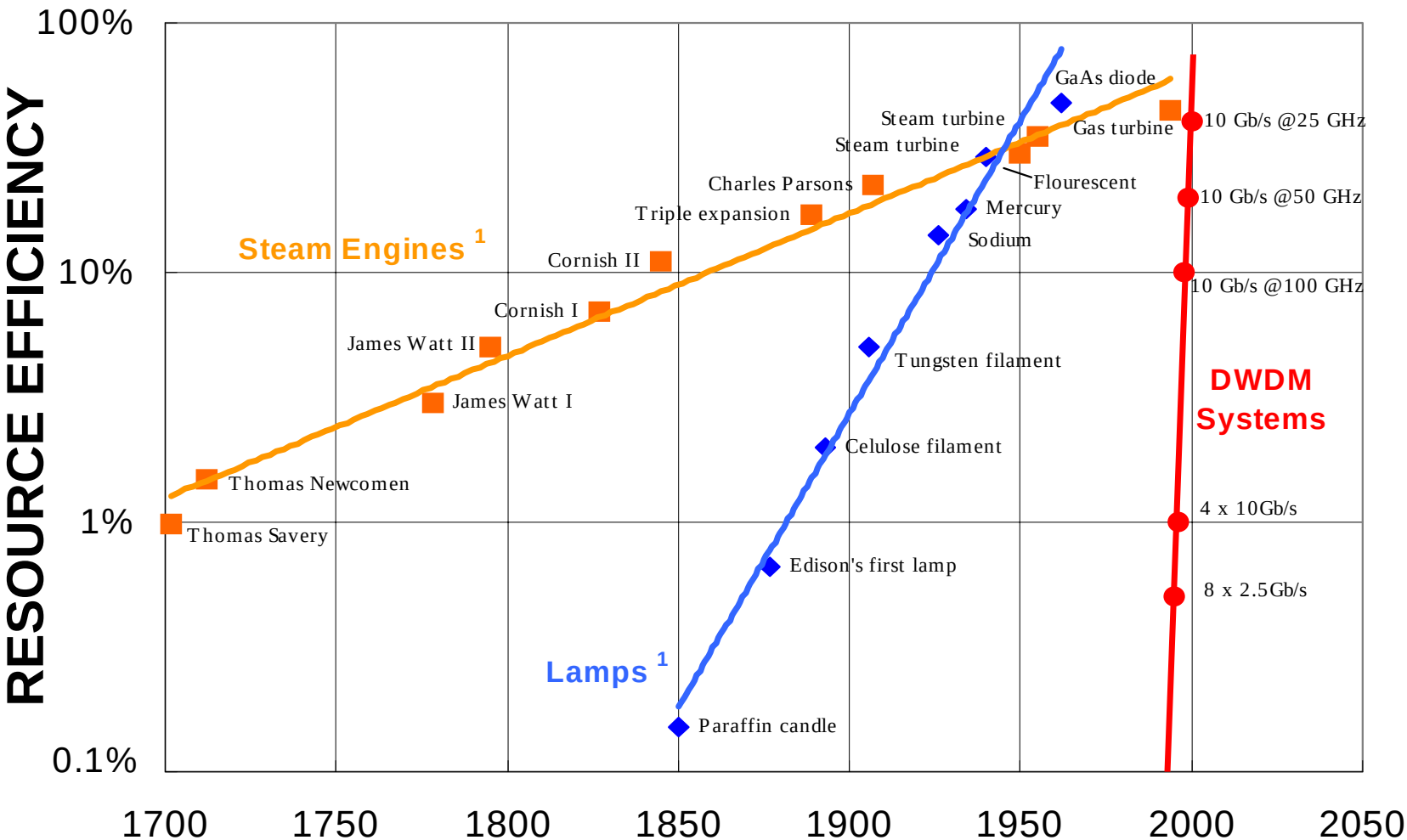
TECHNOLOGY PROGRESS



1) Jesse H. Ausubel, "Where is Energy Going?", The Industrial Physicist, Vol. 6 (1), p. 17 (Feb. 2000).

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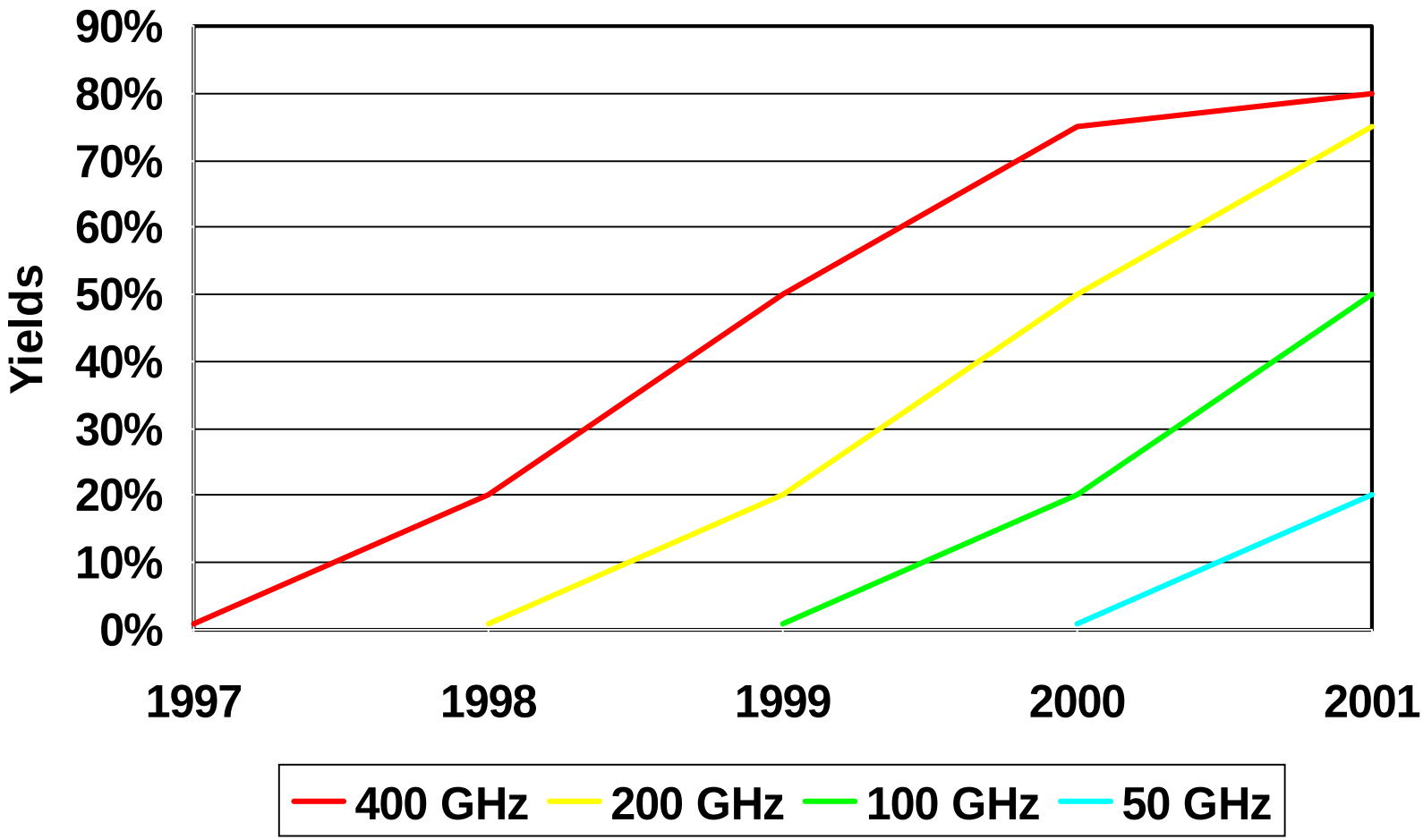
Industry Filter Yield Improvements



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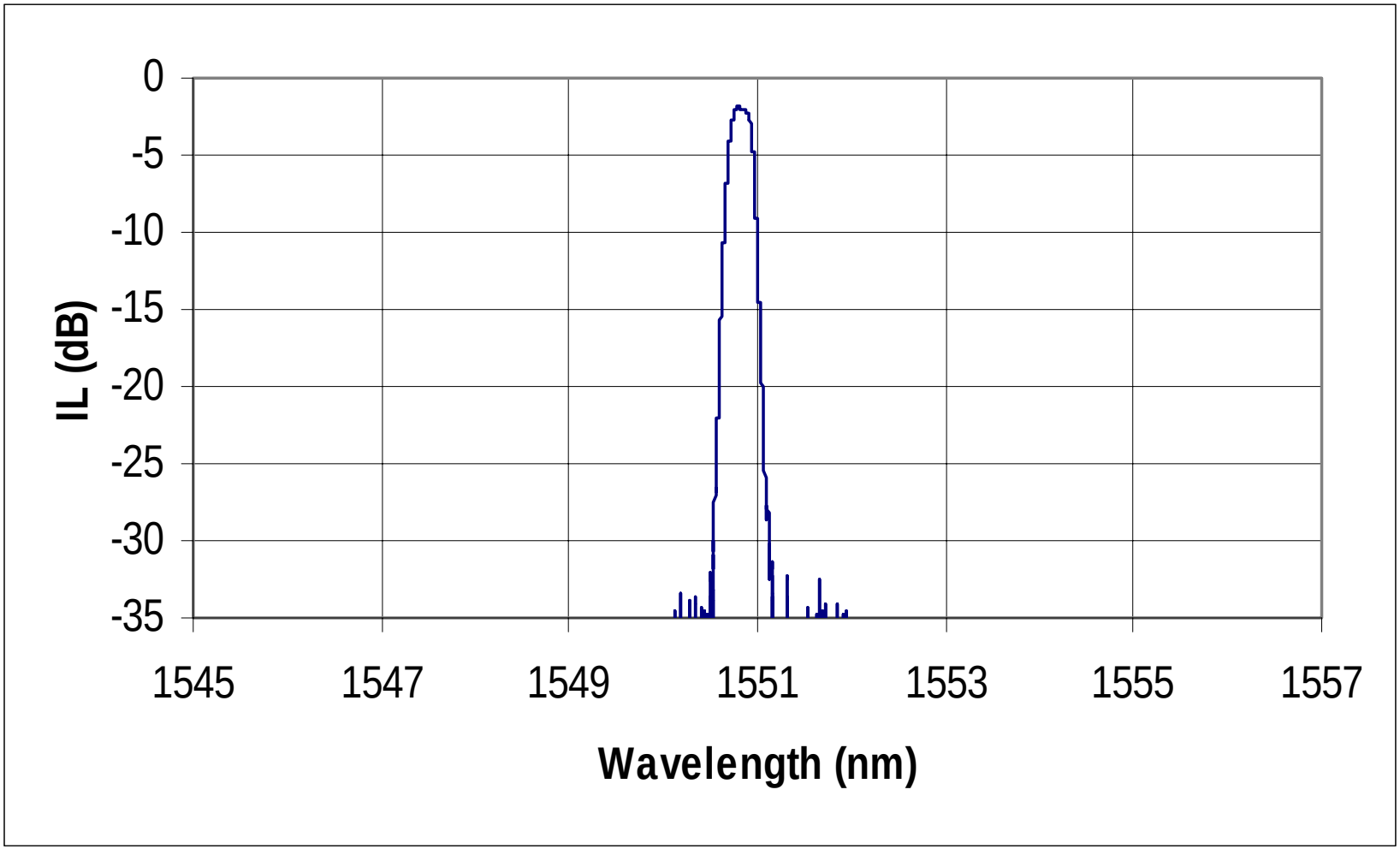
50GHz DWDM Spectrum-Transmission



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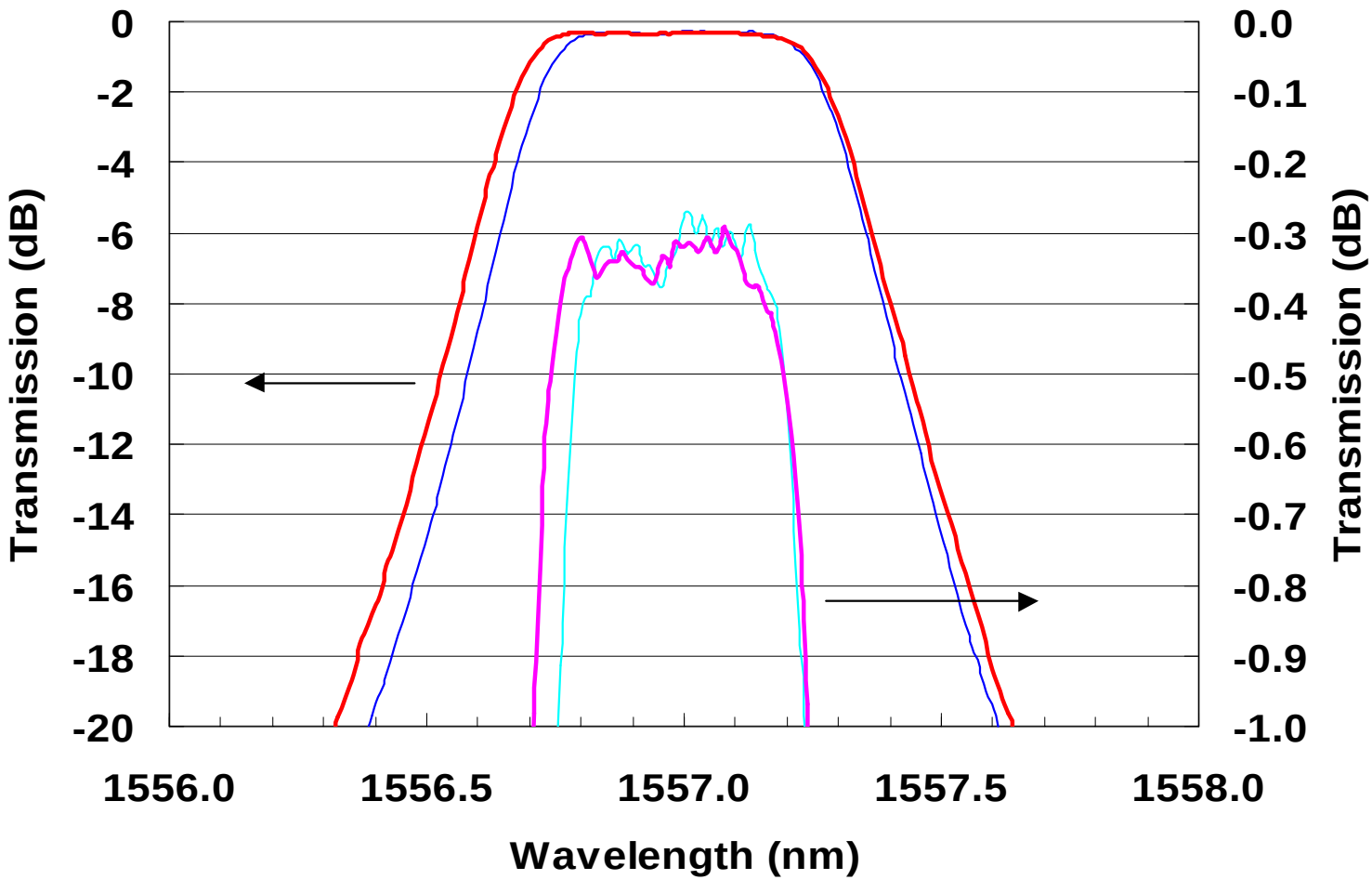
100 GHz Filter Shapes



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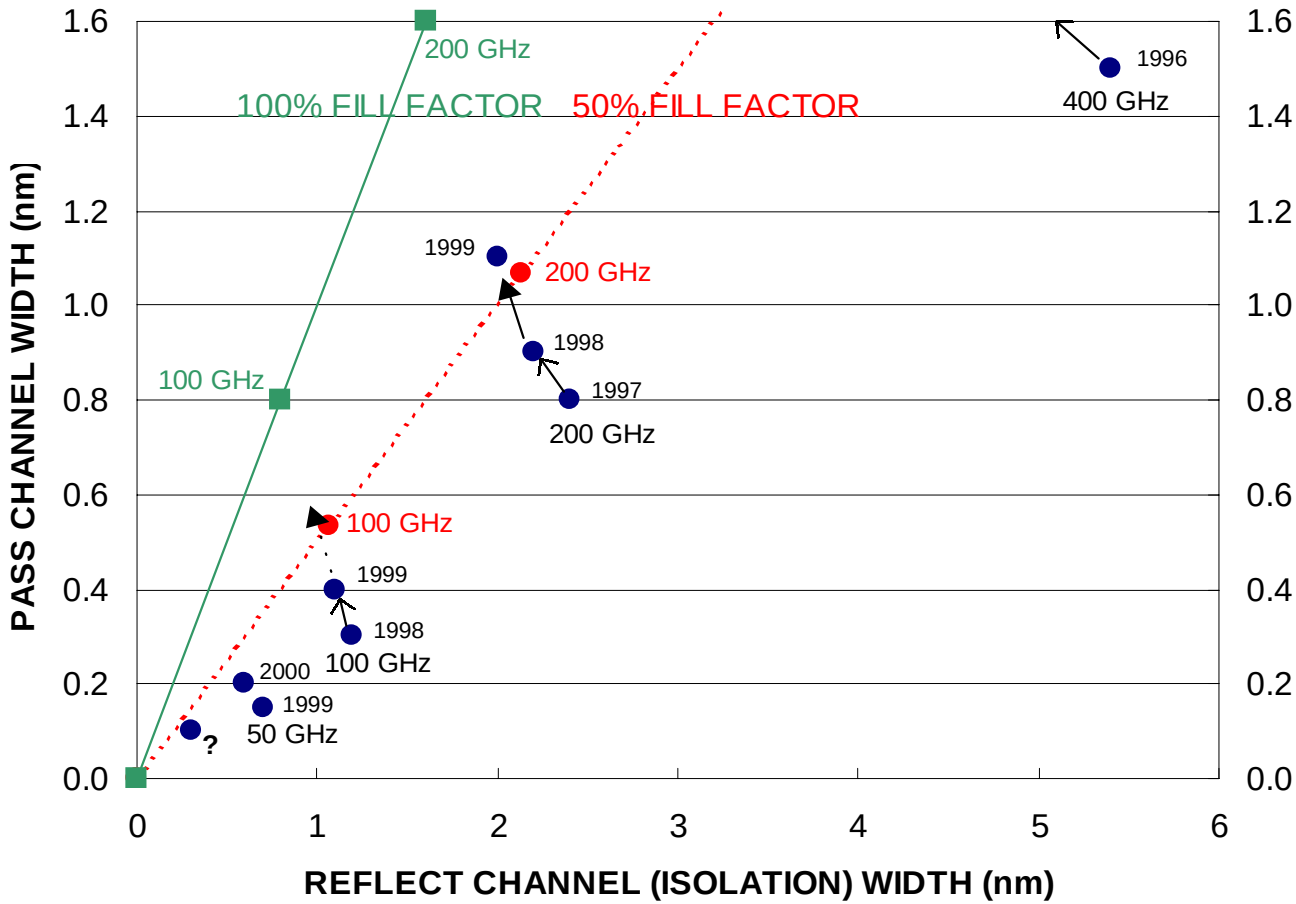
DWDM THIN FILM FILTER PROGRESS



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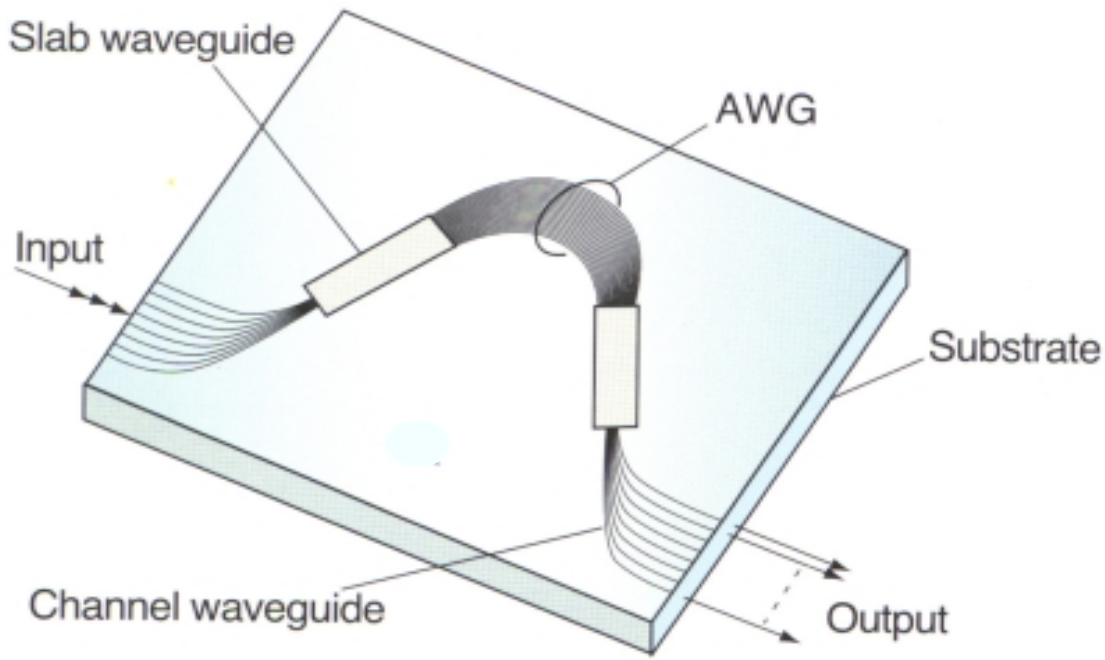
AWG DWDM MUX & DEMUX



Waveguide pattern of AWG multi/demultiplexer chip

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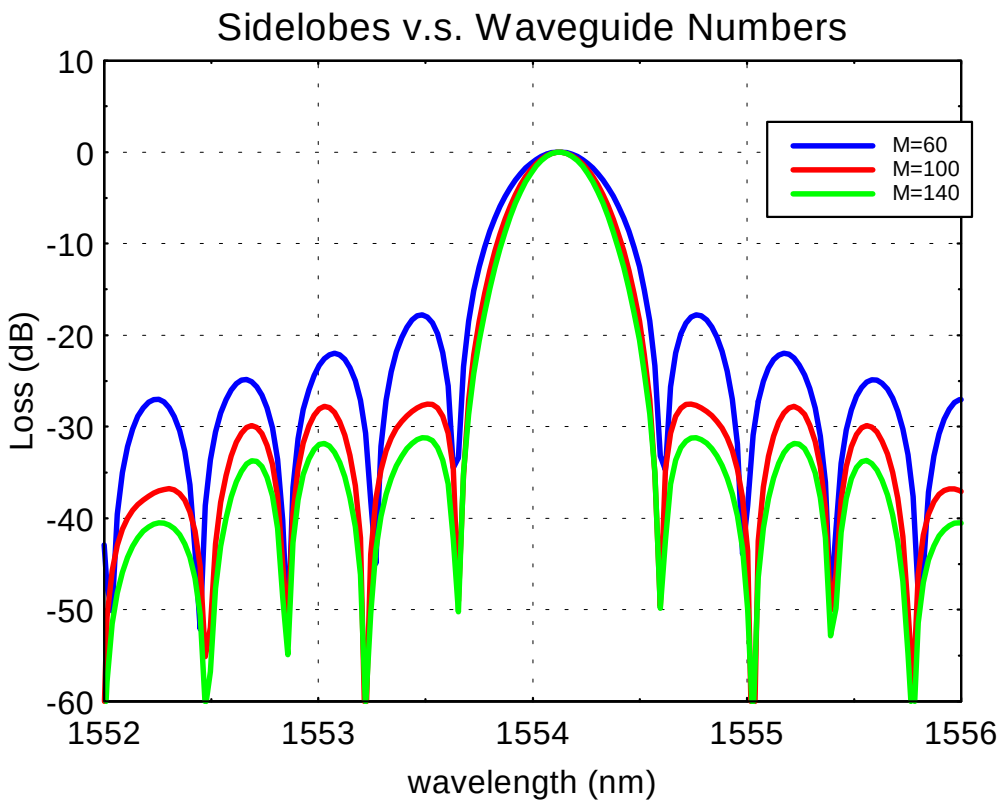
Basic Performance of an AWG



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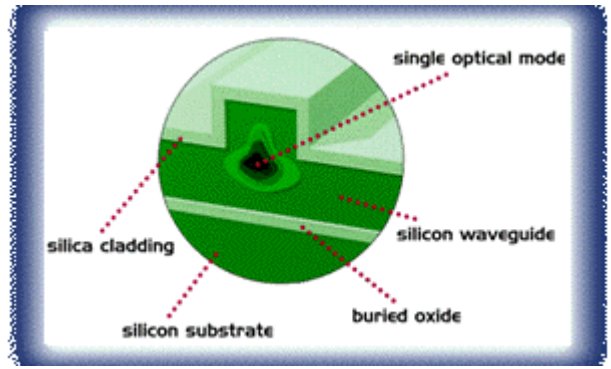
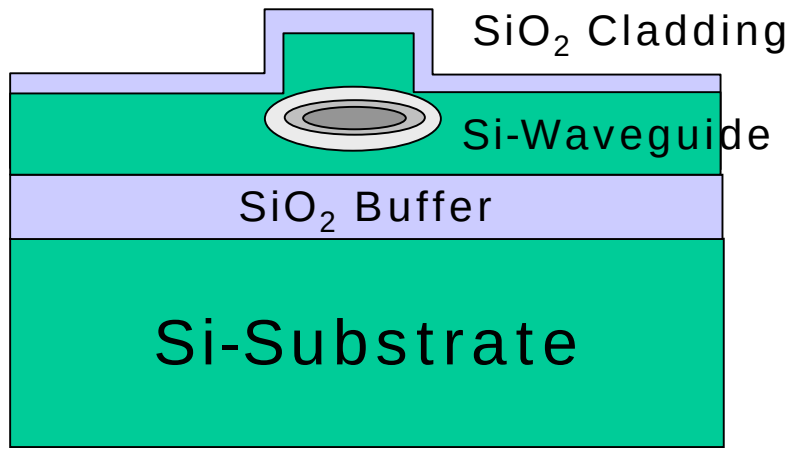
Basic Waveguide Structure

Silicon-on-Silicon
(Bookham Technology)



- easier to manufacture, Si-CMOS process
- pure semiconductor waveguide, small bending radius, small chip size
- difficult to package due to mode miss-match
- few vendors, little R&D
- offer lowest X-Talk
- further integration, OEIC



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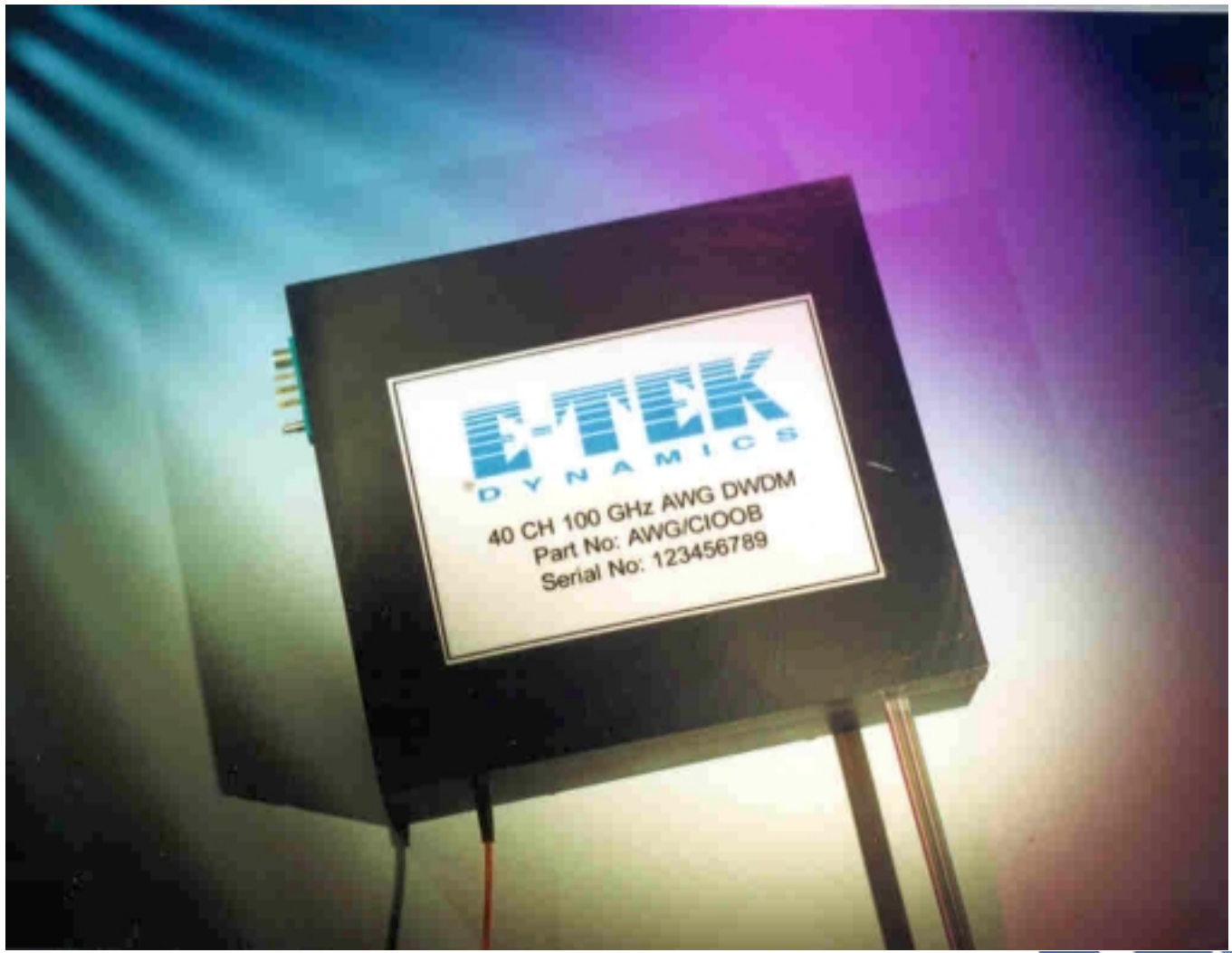
Packaged Silicon AWG



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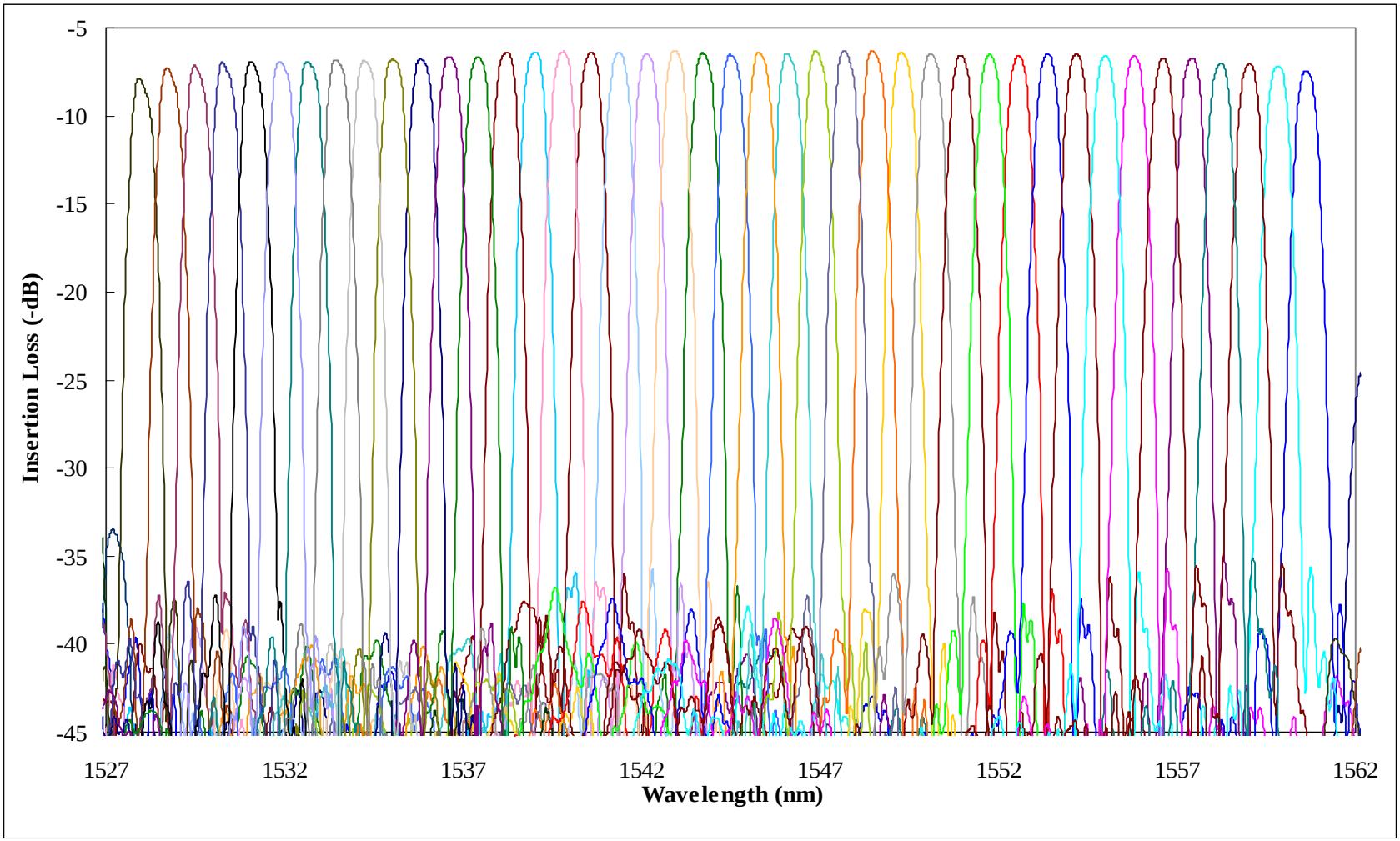
Typical Spectrum of Packaged AWG Module



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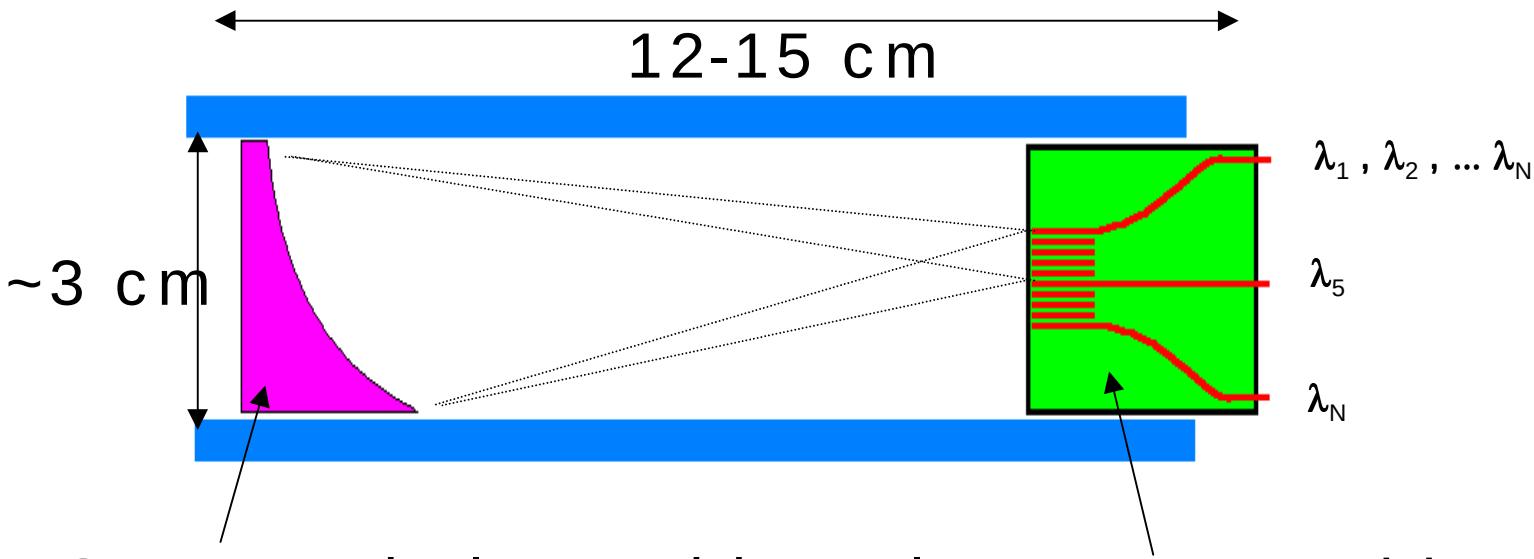
Holographic grating DWM

Simple structure, high channel count



Concave holographic grating

Planar waveguides with S-bends

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Holographic Grating Attributes

- High channel count, yet completely passive
- High isolation >40 dB
- Less developed than PAWG

Issues:

- Channel uniformity
- Passband flatness
- Polarization-dependent loss

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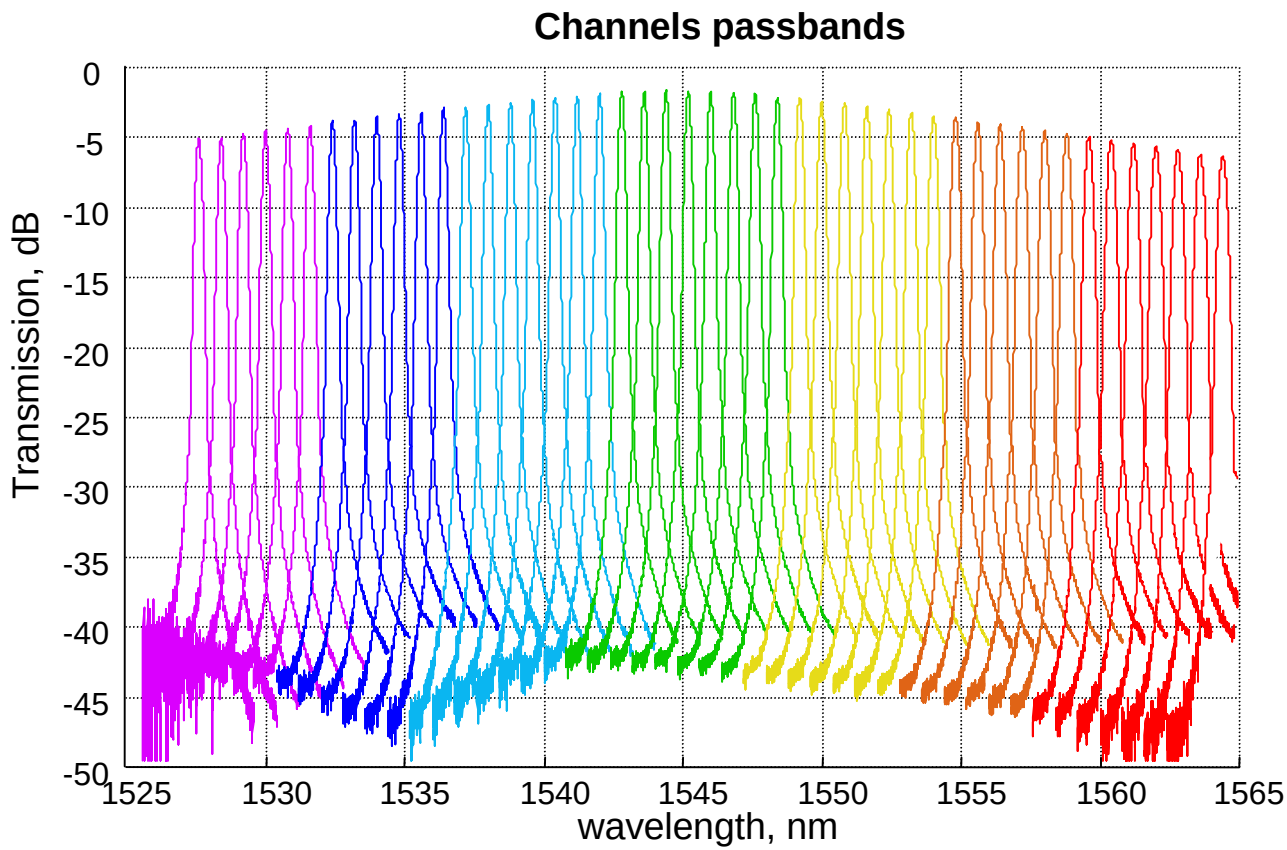
Measured HG Response (Not Flattened)

50 channels @ 100 GHz, not flattened



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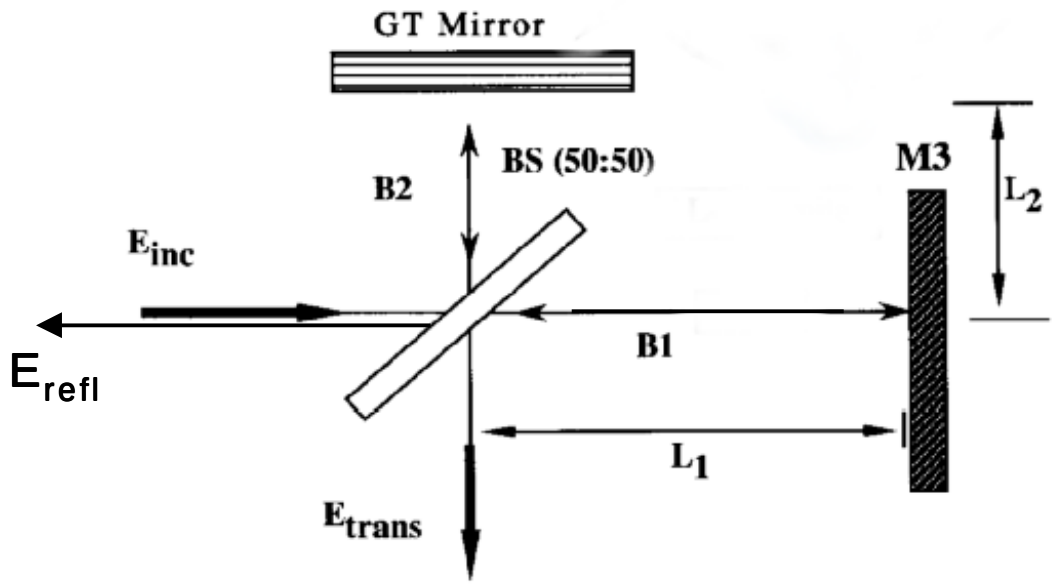
Basic Michelson-Gires-Tournois Interleaver Structure



$$L_1 = 2L_2$$

After Dingel and Aruga, JLT vol. 17(8), pp. 1461, 1999.

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Packaged Prototype 25-GHz Interleaver

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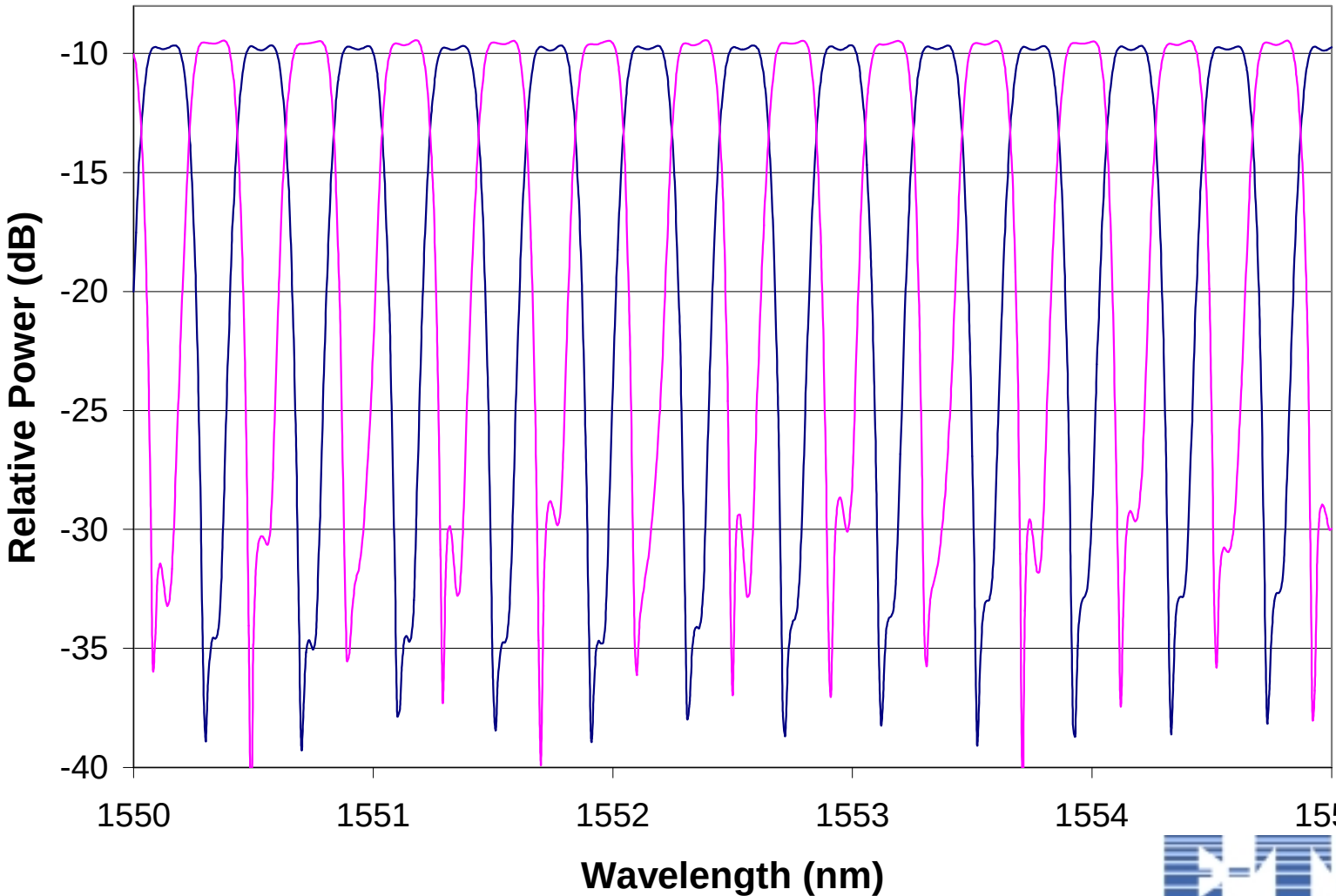
25-GHz Interleaver Characteristics



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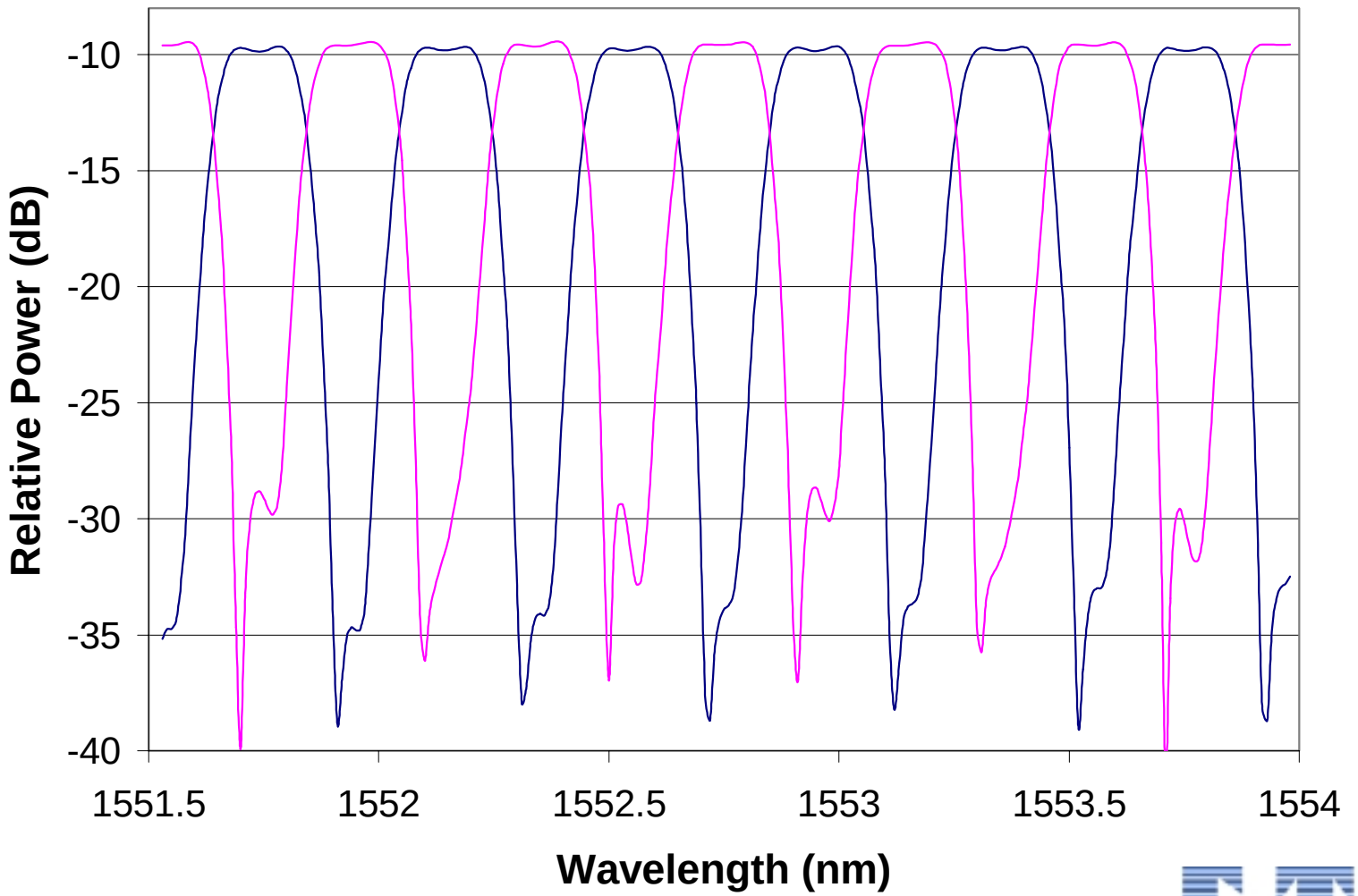
25-GHz Interleaver Characteristics



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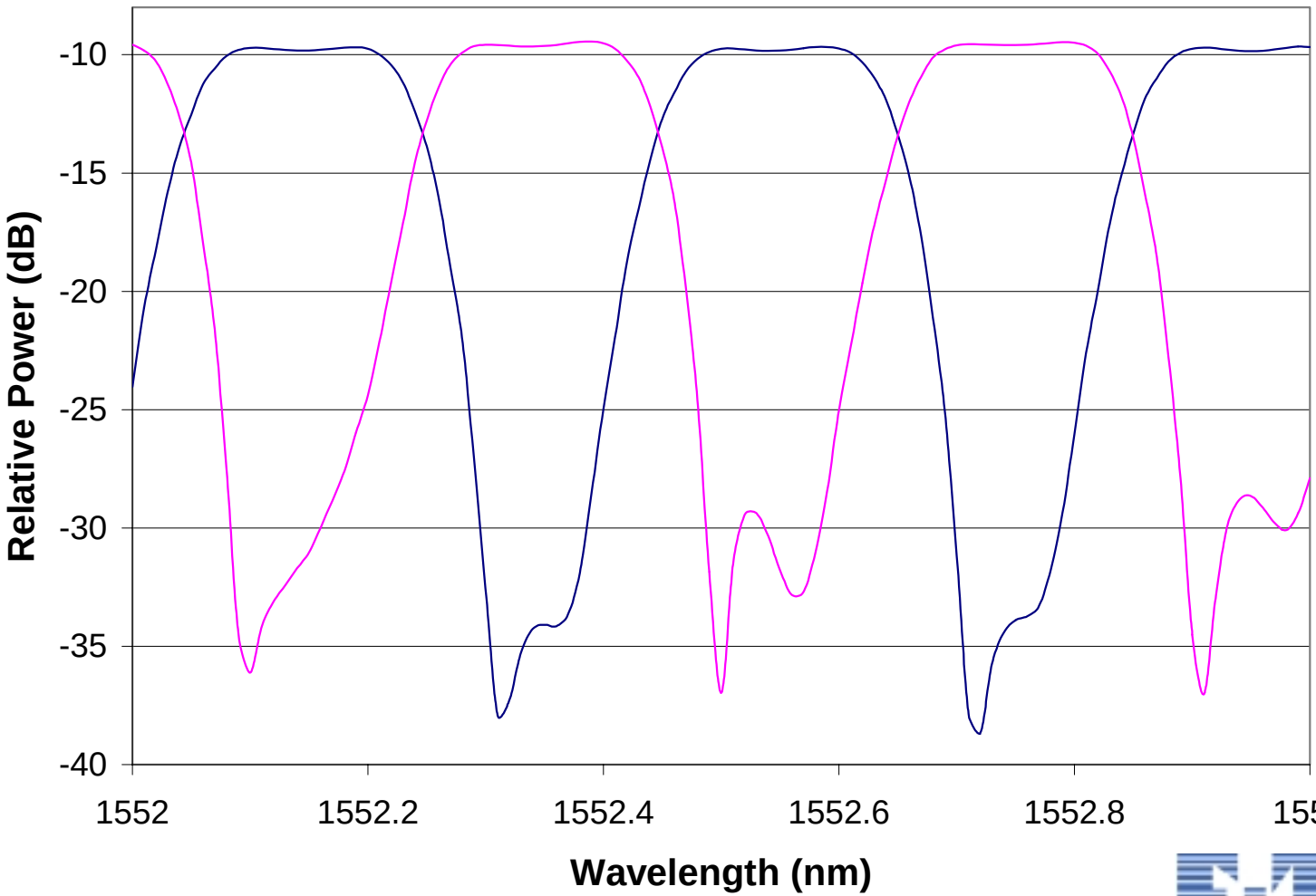
25-GHz Interleaver Characteristics (Insertion Loss ~ 2 dB)



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System Demo with Kestrel

- Using a 25-GHz interleaver and 10-Gbps optical FDM systems, a two-channel ultra-dense WDM system was demonstrated.
- BERs down to 10^{-12} were achieved.
- No BER floor observed.
- Power penalty due to interleaver was negligible.

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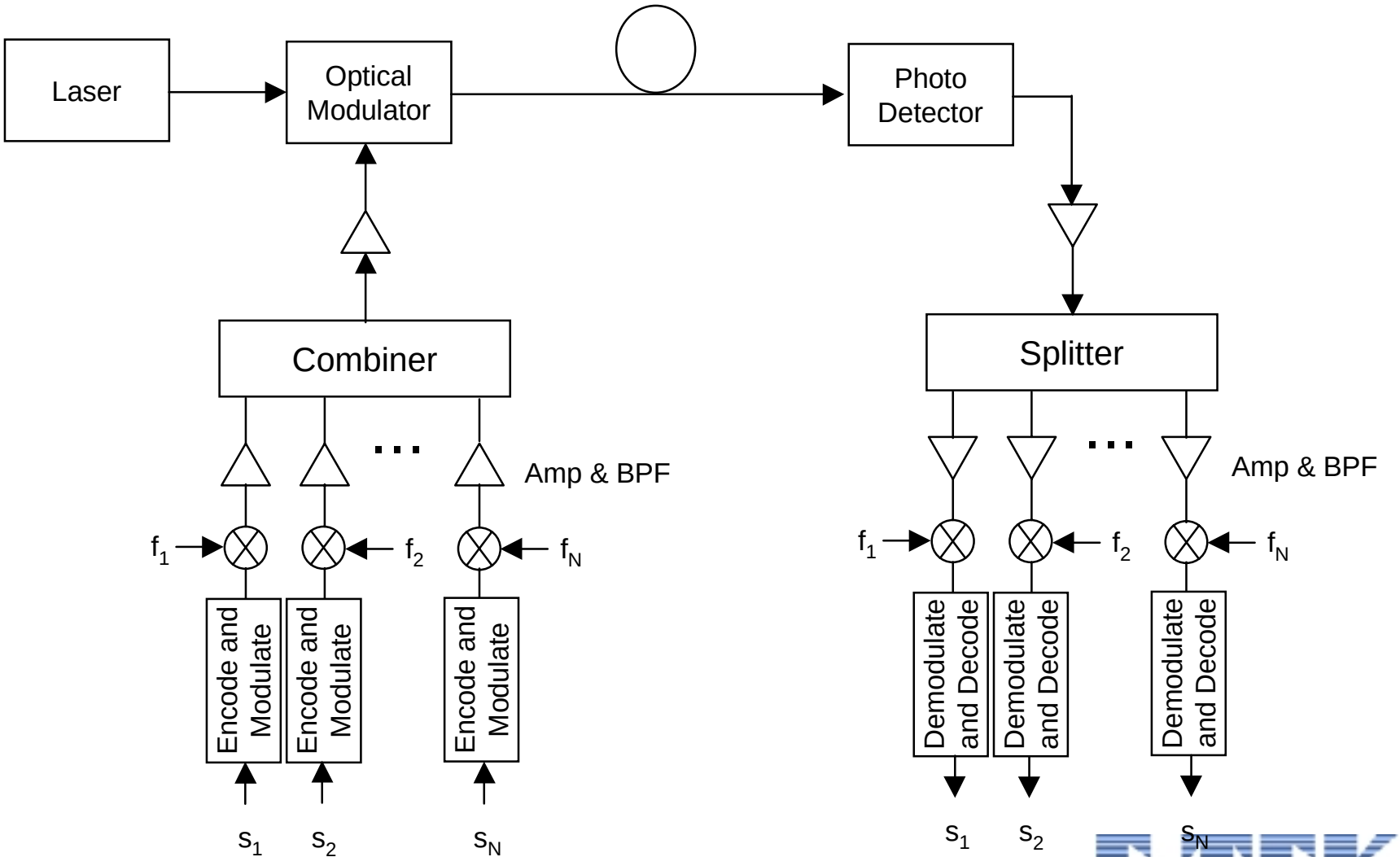
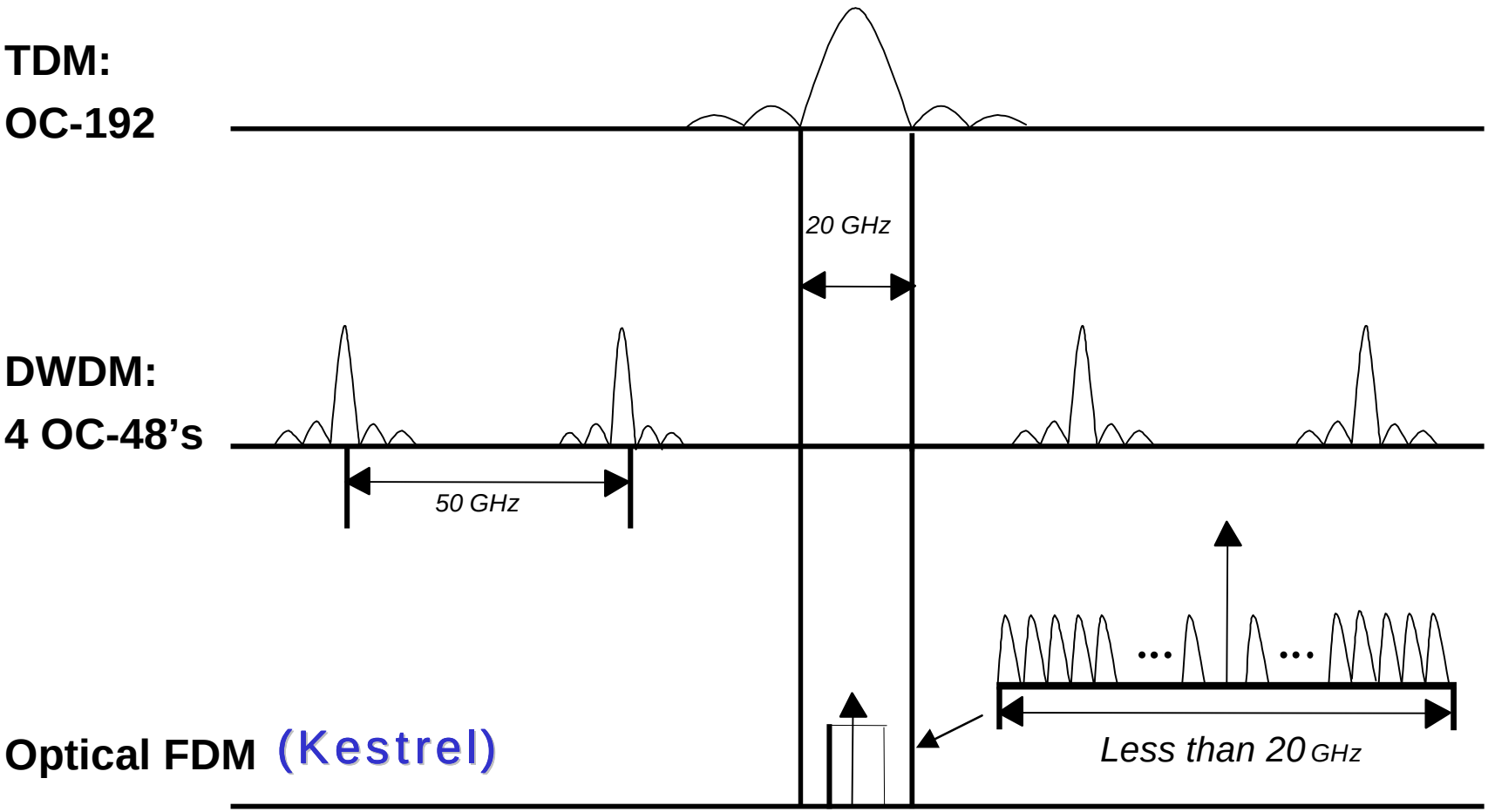
Optical Frequency Division Multiplexing (Kestrel)



Spectra For Three Different Methods Of Transmitting 10 Gbps



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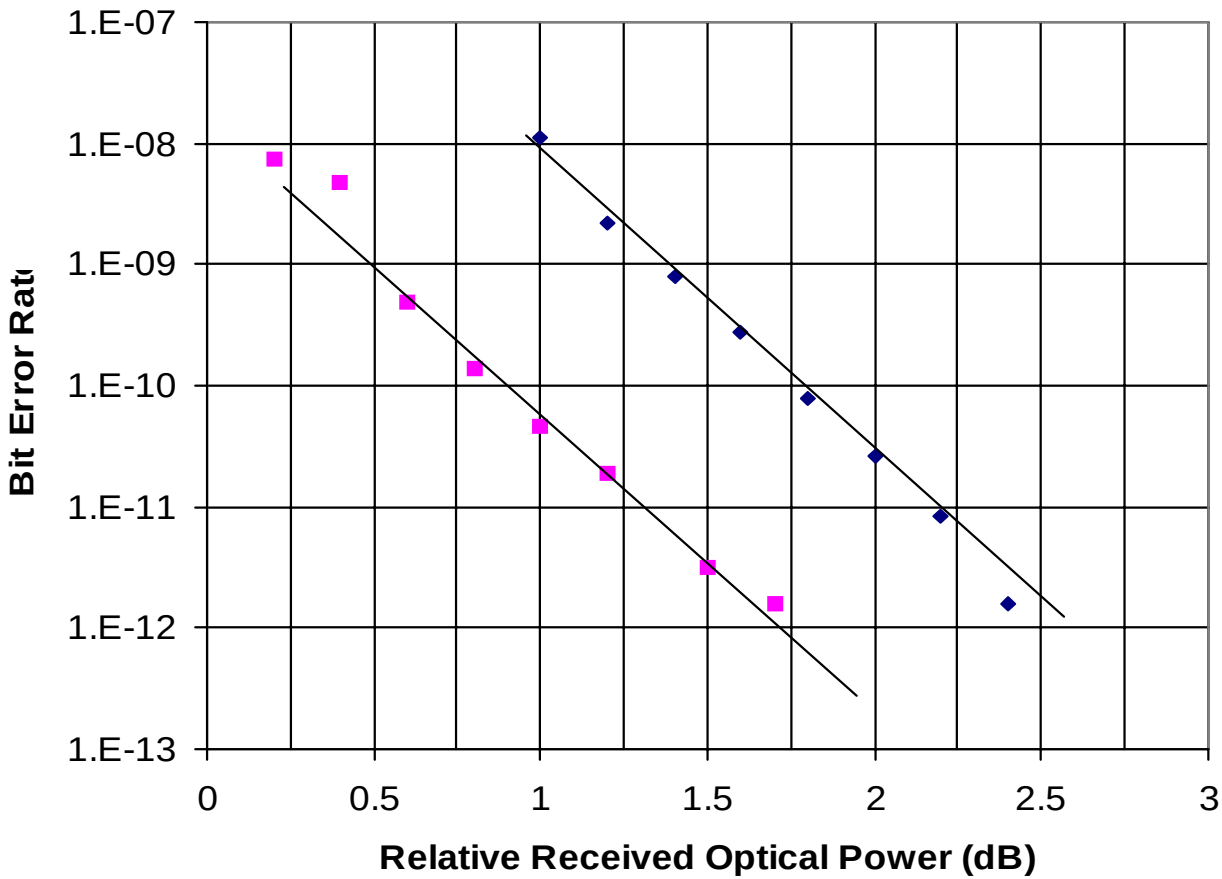
DWDM System BER



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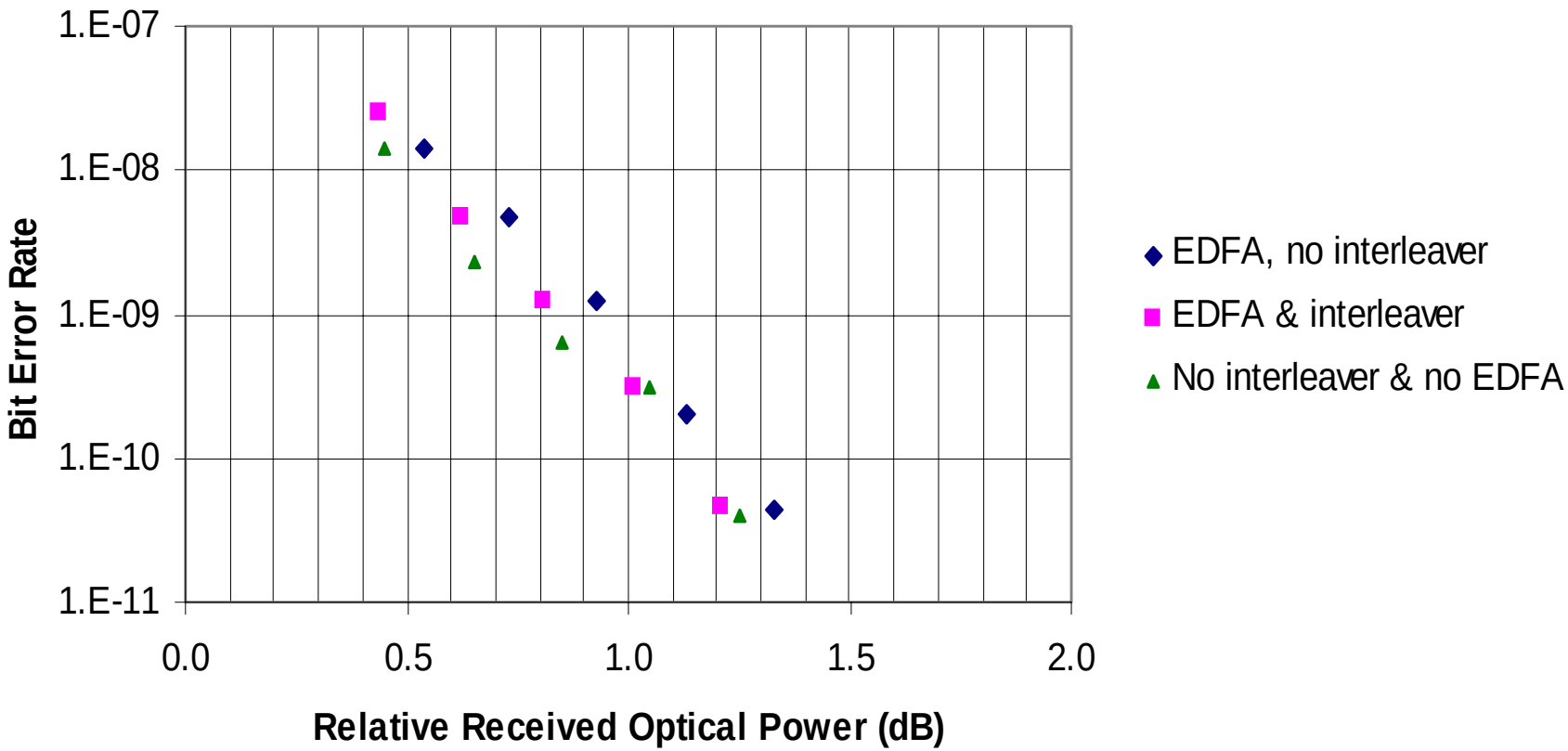
Impact of Interleaver on BER



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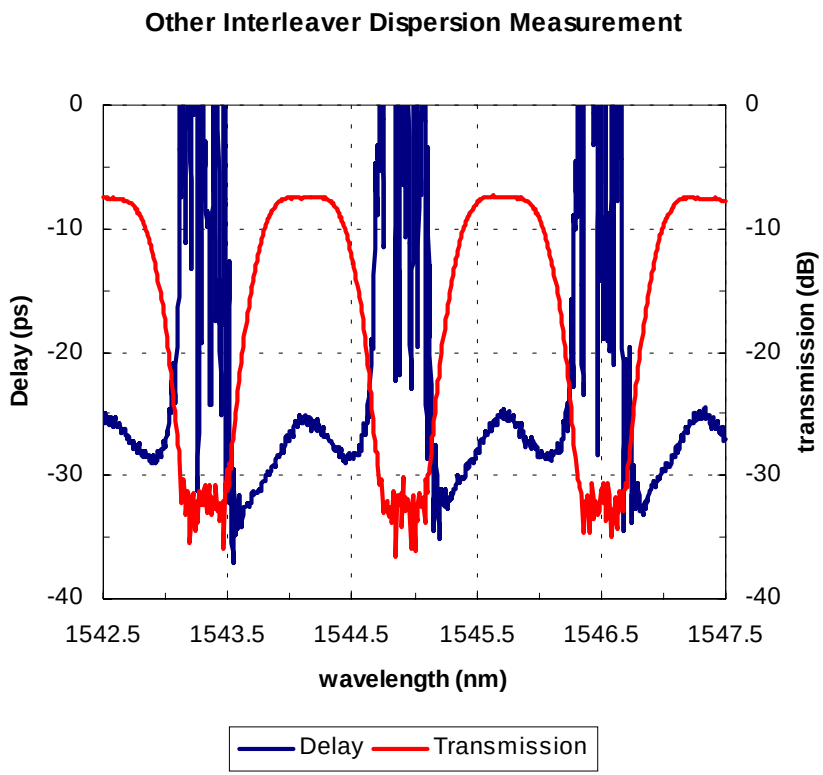
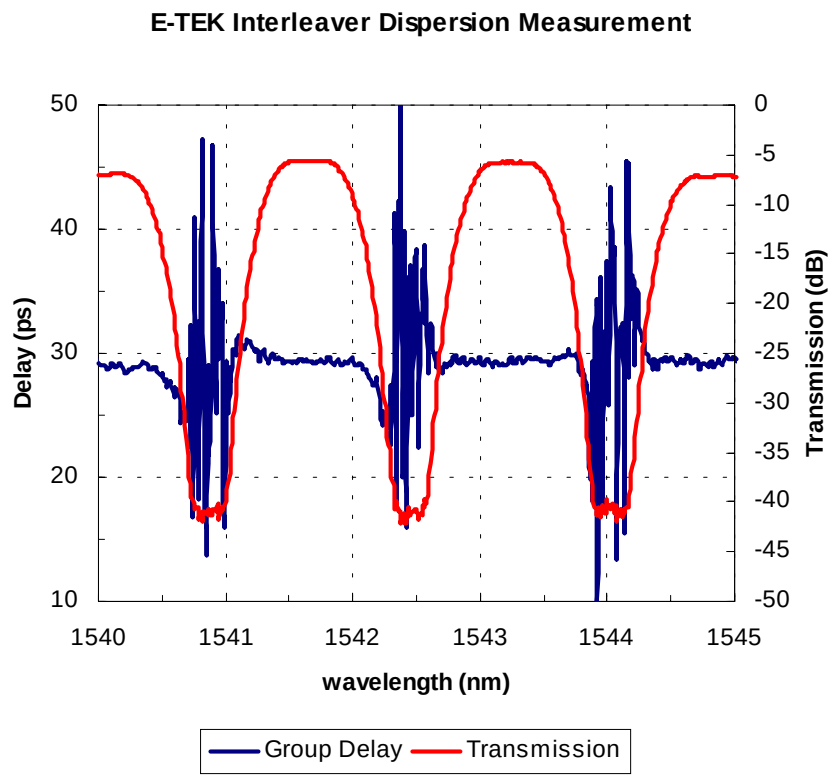
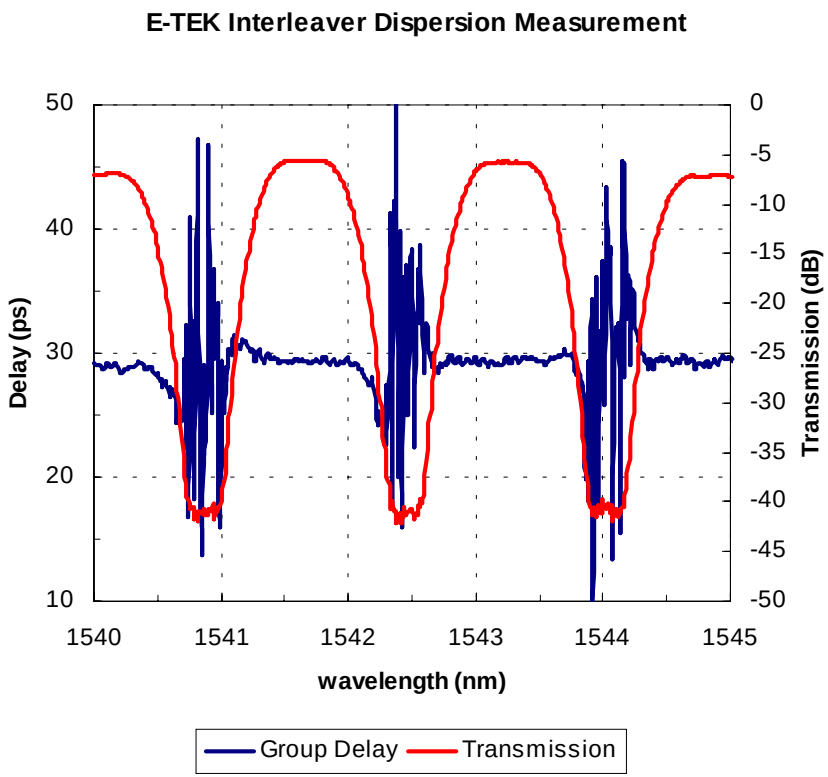
INTERLEAVER DISPERSION

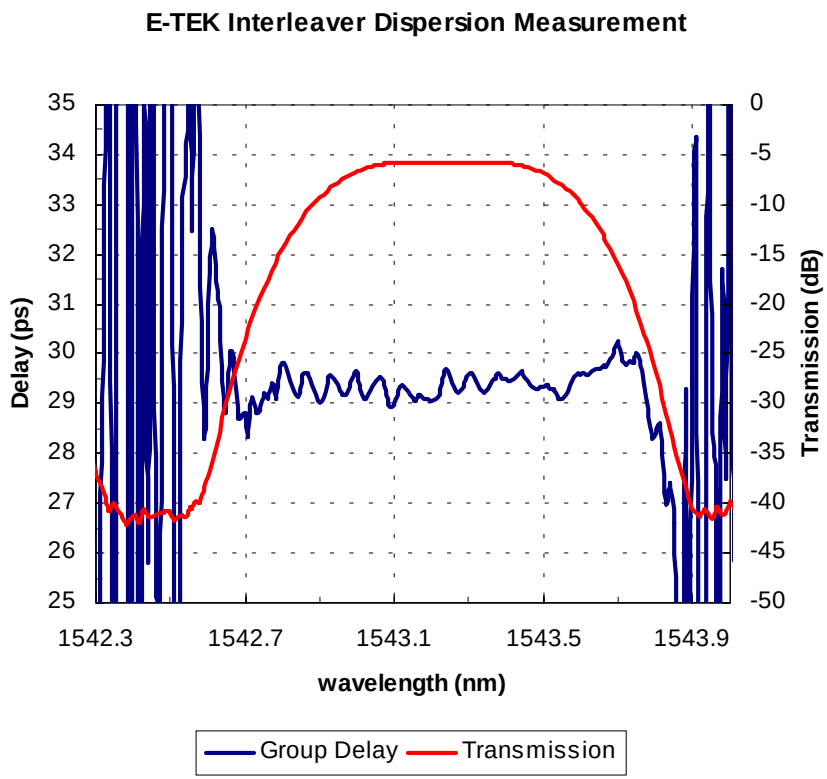




Special Thanks to Agilent Technologies: R. Fortenberry, F. Liang, A. Nooriala, J. Zhang for dispersion measurement

Less Than 1ps DGD





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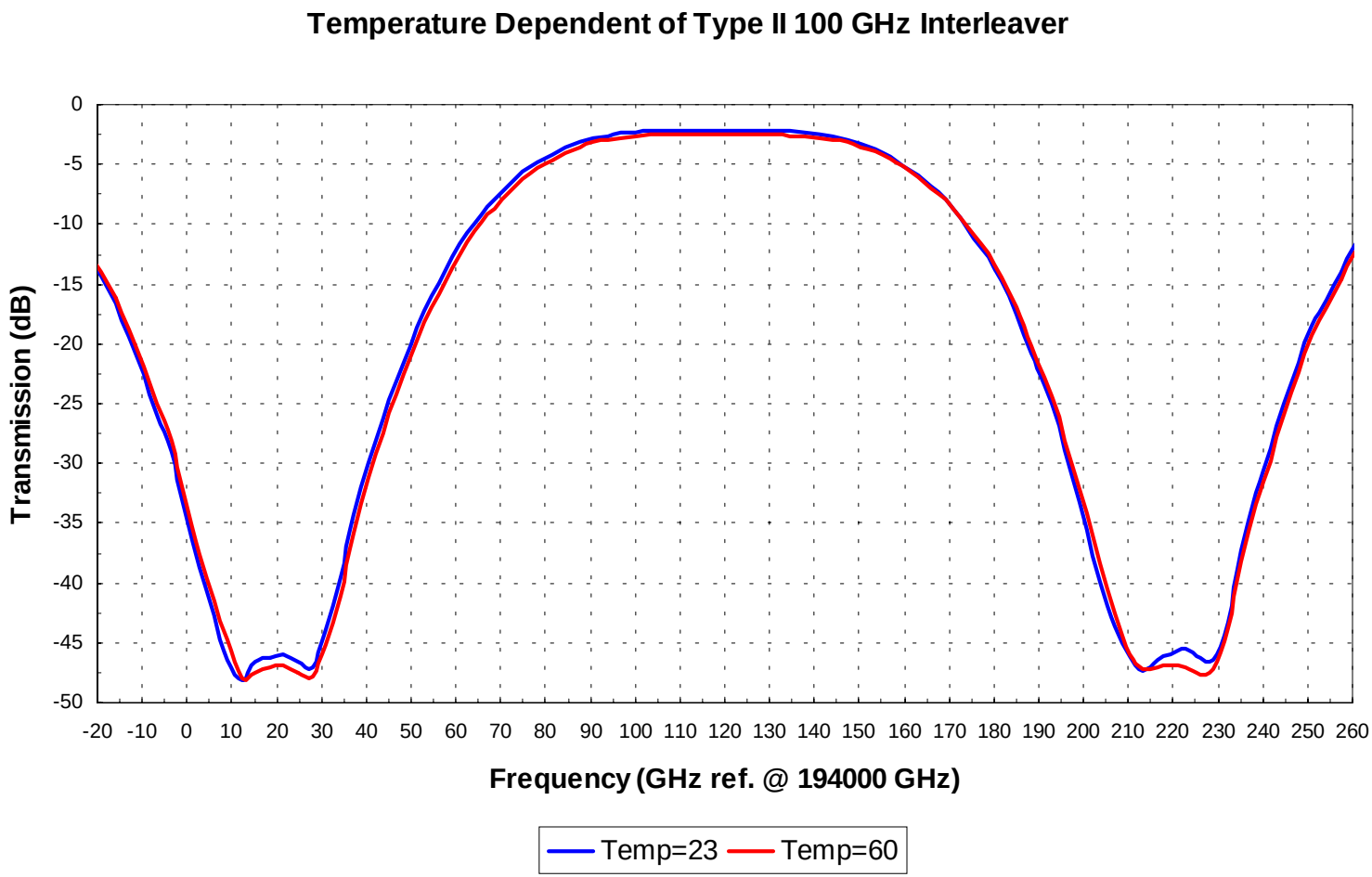
Interleaver Temperature Dependence



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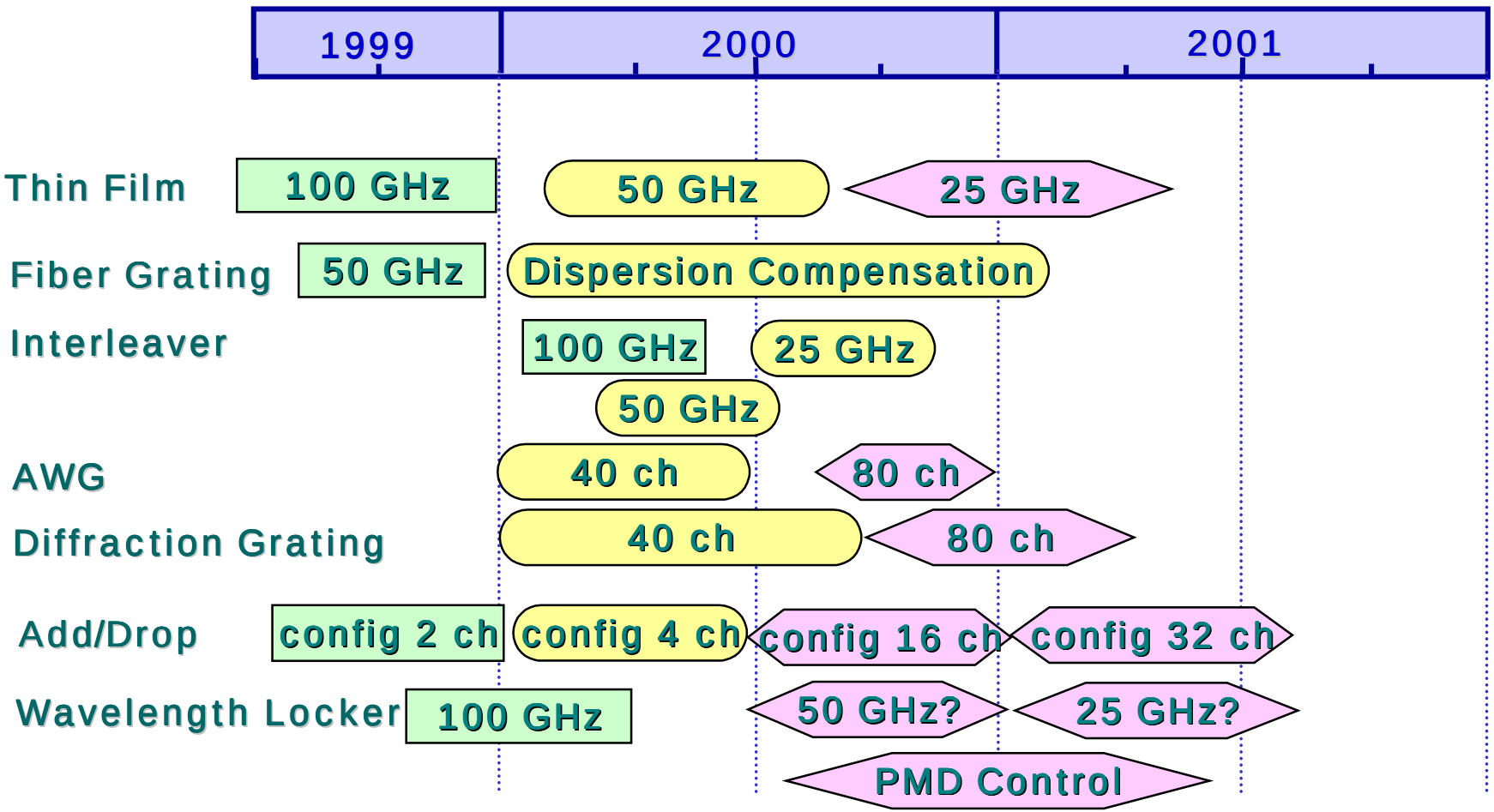
DWDM Component Development Road Map



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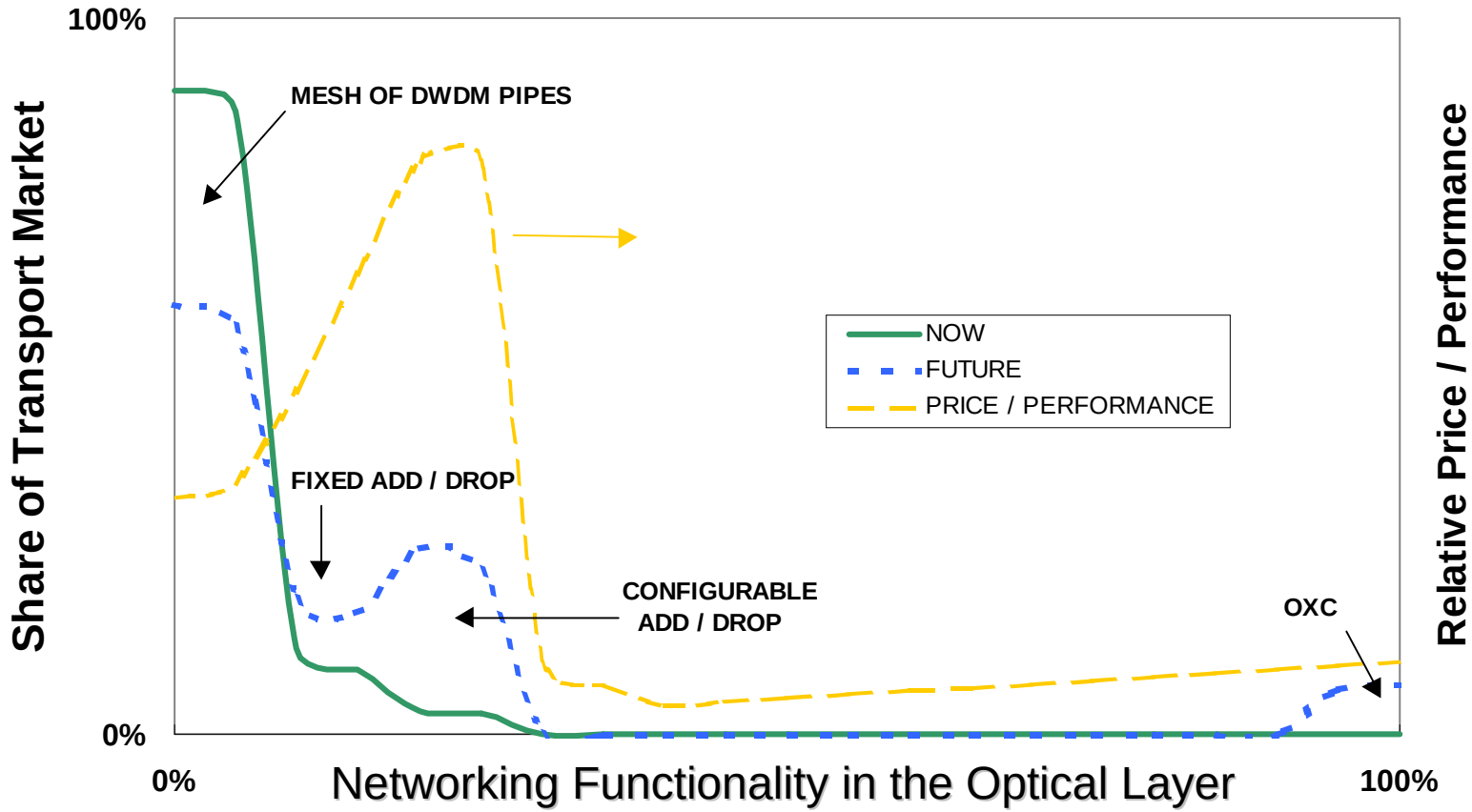
OPTICAL NETWORK EVOLUTION



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